| Application | Frequency |
|---|---|
| All systems | Before system startup, following any major system repair or modification, and following each filter (adsorber) replacement. |
| Radiochemical plants, fuel reprocessing plants, and laboratory fume hoods | Semiannually or quarterly where high moisture loadings or high temperatures are involved. In some systems, frequent (even monthly) testing is often specified where the environment is particularly severe. The frequency may be reduced if experience indicates a lesser frequency is satisfactory. |
| Reactor post-accident cleanup systems and ESF post-accident cleanup systems of fuel reprocessing plants | Annually or 720 hrs of system operation, whichever comes first (as specified in USNRC Regulatory Guide 1.52).[13] |
| Zone III (varies; may be called Zone II) contamination areas of facilities that handle moderate to large quantities of radioactive materials | Annually |
| Zone I and II (may be called Zone II & III) contamination areas of plants and laboratories that handle moderate to large quantities of radioactive materials | Annually |
| Zone IV (may be called Zone I) contamination areas (glovebox lines, hot cell exhaust, etc.) of laboratories and plants that handle moderate to large quantities of radioactive materials. | Semiannually unless experience indicates that annual testing is sufficient. If filters (adsorbers) are replaced at short (less than six-month) intervals to limit exposure of personnel to radiation during a filter (adsorber) change, or to permit contact maintenance of the system by limiting the amount of radiation that can be collected in the filters (adsorbers), systems should be in-place [i.e., leak-tested following each filter (adsorber) change]. Laboratory testing of adsorbents may not be necessary if the adsorbent is replaced frequently. |
| Systems that are continually on standby, but are operated occasionally during plant maintenance to ventilate the system | At least biannually |

It appears that each DOE site has established its own interval for testing HEPA filter systems. It has been strongly recommended that DOE provide guidance concerning test schedules for in-place testing of HEPA filter systems. This area remains to be improved and is further discussed in Section 8.7.[18]

## 8.8 NEEDED IMPROVEMENTS

### 8.8.1 QUALIFIED PRODUCTS LIST

The QPL for qualification of HEPA filters, which was once maintained by the military, needs to be re-established and maintained. With the military's elimination of the QPL for HEPA filters, ASME Code AG-1[3] specifies that qualification may be performed by independent laboratories. The problem is that, with the exception of Edgewood Arsenal, no laboratories have the equipment or inclination to qualify filters. This dilemma must be addressed immediately.

Review and updating of the qualification test protocol is required. Changes may be needed in the heated air, moisture overpressure, environment cycle, or rough handling tests. Additional tests may be needed. This is a challenge for industry.[18]

### 8.8.2 FIELD TESTING IMPROVEMENTS AND TESTING STANDARDIZATION

Improved field-testing methods and equipment require the adoption of testing standards to ensure consistent testing and results. Although commercial nuclear applications apply the ASME N510[10] and ASME AG-1[3] standards, DOE contractors require clarification of the applicable parts of these referenced standards. An in-place testing conference held at the DOE SRS recognized that standardization of DOE contractors' in-place testing procedures for DOE applications was in order. The group also identified the following areas for improvement.[18]

1. Referencing ASME N510[10] for testing of DOE filter systems results in auditing confusion and problems in demonstrating compliance with the referenced requirements.
2. Filter specification (ASME/DOE) clarification is needed.
3. Improvements are needed in the areas of standards, procedures, training requirements, and certification for filter test technicians.
4. A DOE guidance document or standard for testing unique filter systems at DOE sites should be developed.
5. Guidance on filter service life should be developed.
6. The challenge test aerosol used by DOE contractors should be standardized.
7. Mandatory/optional requirements for the in-place test procedure should be standardized.
8. More stringent receiving inspection/QA requirements need to be developed and more training of personnel in this area is needed.
9. QPL requirements for cylindrical filters should be developed.
10. A decision is needed concerning whether FTF QA testing will continue, and which facility will perform a laboratory efficiency test versus a leak test.
11. A decision is also needed to establish the testing protocol for HEPA filter vacuums and portable ventilation units.

### 8.8.3 Aging of HEPA Filters

An established standard for replacement of HEPA filters based solely on the age of the filter does not exist in national standards. LLNL recently developed the requirement that HEPA filters shall be replaced 10 years after the date of manufacture. The exceptions to this requirement are as follows:

- Any such filter that has become soaked o which could have become soaked, as from the activation of an in-duct water sprinkler or from spraying water directly on the filter, shall be replaced promptly.
- Any such filter that could become soaked (e.g., from activation of an in-duct water sprinkler) shall be replaced within 5 years of the date of manufacture.[39]

The underlying rationale for this set of requirements is found in Reference 35 at the end of this chapter. LLNL identified four experimental studies and one analytical study that showed age causes deterioration of filter strength and water repellency.[35] The role of water in weakening filters is discussed elsewhere in this handbook and will be discussed in the following text. The current criterion for replacing a HEPA filter is when it fails an in-place leak test or a prescribed pressure-drop limit. However, experimental studies of the effects of age on HEPA filter performance conclude that the filters do deteriorate with age. To address the issue of aging installed HEPA filters at DOE sites. The historical measures of filter strength are (1) the tensile strength of the paper in combination with a 10-in. (254 mm) overpressure test on the filter and (2) burst strength. Burst strength (the pressure required to tear open the media) measures two-dimensional stretches compared to the one dimension used to measure tensile strength. Brittleness of the media—measured by flexing it—is a third major indicator of strength, although it is not generally measured in aging studies (several authors have noted that aged HEPA filters are very brittle).

Water repellency is another critical parameter because water causes filter plugging and decreases tensile strength. Unfortunately, critical filter parameters such as media tensile strength and water repellency vary widely due to manufacturing differences and particulate deposits. These varying parameters frequently mask the effects of age, making it difficult to derive an age limit using the available studies.

A peer-review meeting held at the Rocky Flats Environmental Technology Site on March 6, 1997, explored methodologies for establishing in-service and in-storage HEPA filter lifetimes. Participants included representatives from manufactures of filters, filter paper, and glass fiber; DOE officials and contractors; and representatives from academia.

After an extended discussion about potential laboratory methods for determining age limits, the participants concluded that no established accelerated aging tests could be used to establish HEPA filter lifetimes. The aging process of glass fibers cannot be separately determined from the aging of the glass fiber medium because of the effect of the binder, water repellency, and other treatments. The consensus from the 1997 meeting was that the only currently reliable experimental method for establishing age limits is to conduct selected criteria tests on field-aged HEPA filters. Unfortunately, this approach can only offer limited success because the broad range of variability in manufacturing quality will mask the effects of aging.

Nondestructive tests cannot measure filter deterioration caused by age. The annual in-place filter leak tests do not provide assurance that age-deteriorated HEPA filters will perform during high-stress accident conditions Johnson et al. showed that even several aged and weakened filters may not suffer from a loss of filter efficiency.[35]

## 8.9 Review of In-Place Filter Testing at Selected DOE Sites

In 1992 and 1993, LANL performed a two-year review of the large HEPA filtration systems at seven different DOE sites, including:

- Paducah Gaseous Diffusion Plant
- Portsmouth Gaseous Diffusion Plant
- LANL, Area 200 of FP4, Technical Area 55
- Plutonium Fuel Fabrication Facility and Plutonium Experiment Facility at SRS
- High Flux Beam reactor and Medical Research Reactor at Brookhaven National Laboratory
- Buildings 38 and 50 at Mound Plant (Mound)
- ORNL, High Flux Isotope Reactor, Radiochemical Engineering Development Center and Isotope Enrichment Facility

Although significant differences between the sites were found, there were also several common issues. The observations were divided into four areas:

**Policy Development.** [Includes filter shelf life, filter service life, role of HEPA acceptance and in-place filter testing and system oversight.] The goal should be to provide a technical basis for setting maximum storage and service times after which filters must be discarded or replaced.

**Testing Multi-stage Systems.** [Includes overall system and individual stage testing.] Requirements in this area include clarification for the use of acceptance-testing filters, the need to test intermediate stages of multiple stage systems, appropriate requirements for testing filters used with gloveboxes, and the types and degree of administrative oversight and record-keeping necessary when HEPA filers are part of exhaust and air emission control systems.

**Guidance on In-place Filter Testing and System Supervision.** [Includes testing practices, test equipment maintenance and calibration, special concerns of older systems, measurement uncertainty, pass/fail decisions, frequency of routine testing, analysis and reporting of testing results, and technical support and training of testing personnel.]

**Uncertainty in In-place Filter Testing Results.** The issue of how such results are affected by measurement methods, system characteristics, and system abnormalities needs to be studied.

Two principal conclusions have emerged from these reviews. First, there is an immediate need to develop information on how filter mechanical integrity decreases with time, and to use this information to establish limits on filter service life. Second, there is a general need to ensure the validity of in-place filter testing results and to improve testing practices. A mathematical framework for describing the effects of abnormal system features on testing results is proposed as an aid in understanding the uncertainty in in-place filter testing results.[36]